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# RESPONSE OF VERMICOMPOST AND *AZOTOBACTER* ON GROWTH AND YIELD OF 'SWEET CHARLIE' STRAWBERRY

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## ABSTRACT

The present study was conducted to find out the response of vermicompost and *Azotobacter* on growth and yield attributes of strawberry (*Fragaria* × *ananassa* Duch.) cv. 'Sweet Charlie' during 2014-2015. Vermicompost and *Azotobacter* were applied separately and in combination at 100 q/ha and 30 ml/litre water, respectively. Different treatment combination revealed significant positive effect on most of the parameters studied under the experiment. Maximum plant height (11.25 cm), plant spreading (27.76 cm), number of leaves (14.28), leaf length (5.25 cm), leaf width (4.17 cm), leaf area (33.07 $cm^2$) were recorded in $T_4$. Similarly, fruit width (3.96 cm), fruit length (5.33 cm), fruit weight (20.96 g), fruit volume (20.93 ml), fruit yield per plant (124.46 g) and fruit yield per plot (4.43 kg) were also observed in $T_4$. Number of flowers per plant (15.91) and number of fruits per plant (6.76) was found in $T_5$ whereas; maximum numbers of runners per plant (3.73) were recorded in $T_6$. Conclusively, $T_4$ (vermicomost 75 % + *Azotobacter* 25 %) was found most effective to improve growth and yield parameters of strawberry cv. Sweet Charlie.

**KEYWORDS:** Vermicompost, *Azotobacter*, Growth, Yield, Sweet Charlie, Strawberry

## INTRODUCTION

Strawberry (*Fragaria* × *ananassa* Duch.) an octoploid having chromosome number (2n = 56) is a dicotyledonous, perpetual low-growing herb grown in most arable regions of the world. Strawberries are good sources of vitamin and minerals (Singh et al., 2007). In India, during last decade, it has become favourite fruit among growers because of its remunerative prices and higher profitability. Further, availability of day neutral and high-yielding varieties has resulted in phenomenal increase in its area and production (Sharma et al., 2004; Paramanick et al., 2005).

Nutrition is one of the important aspects of crop production among the various factors which contribute in growth and yield. Vermicomposts can significantly influence the growth and productivity of plants (Sinha et al., 2009). Vermicompost, which is a stabilised organic material produced by interactions between earth-worms and microorganisms, in a non-thermophilic processes, has been reported to enhance seed germination and growth and plant yields in a greenhouse (Atiyeh et al., 2000) and to improve growth and plant yield under field conditions (Arancon et al., 2004). Vermicompost represented hormone-like activity and increased the number of roots, thereby, enhancing nutrient uptake as well as plant growth and development (Alvarez and Grigera, 2005).Vermicompost improves plant growth may resulted from the modified physiochemical and microbiological characteristics of the soil, increased availability of macro and micro nutrient elements (Anwar et al., 2005). Vermicompost is an environmentally acceptable means for convert waste to nutritious compost (Singh et al., 2010).

Vermicompost increases nutrient content, enhances soil respiration and different enzymatic activities (Dehydrogenase, urease, β-glucosidase, phosphatase, arylsulfatase and activates microorganisms in soil (Tejada et al., 2010)

Vermicomposts restrain nutrients such as nitrates, transferable phosphorus, soluble potassium, calcium and magnesium in plant available forms (Orozco et al., 1996; Edwards 1998). Separately from providing mineralogical nutrients, vermicomposts also contribute to the biological fertility by adding beneficial microbes to soil. Mucus, excreted through the earthworm's digestive canal, stimulates antagonism and competition between diverse microbial populations resulting in the production of some antibiotics and hormone-like biochemicals, boosting plant growth (Edwards and Bohlen, 1996). Adding up vermicompost to soil improves soil structure, fertility, plant growth and suppresses diseases caused by soil-borne plant pathogens, increasing crop yield (Singh et al., 2008).

*Azotobacter* represents the main group of heterotrophic, non symbiotic, gram negative, free living nitrogen-fixing bacteria. They are capable of fixing an average 20 kg N/ha/year. The genus *Azotobacter* includes 6 species, with *A. chroococcum* most commonly inhabiting in various soils all over the world (Mahato et al., 2009). Besides nitrogen fixation, *Azotobacter* also produces thiamin, riboflavin, indole acetic acid and gibberellins. When *Azotobacter* is applied to seeds, seed germination is improved to a considerable extent, so also it controls plant diseases due to above substances produced by *Azotobacter*. *Azotobacter* species are free living bacteria which grow well on a nitrogen free medium and are an important source of bio-fertilizers. These bacteria utilize atmospheric nitrogen gas for their cell protein synthesis. This cell protein is then mineralized in soil after the death of the *Azotobacter* cells thereby contributing towards the nitrogen availability of the crop plants thus resulting in a strong symbiotic relationship (Haller and Stople, 1985). They also exudates some compounds like auxins, cytokinin and antibiotics improving growth and productivity of the crops (Forlain et al., 1995).

## MATERIALS AND METHODS

The experiment was carried out at Horticultural Research Farm, Babasaheb Bhimrao Ambedkar University (Latitude $26^0$ 46′7′′N and longitude $80^0$55′38′′E, altitude of 129 m asl), Lucknow, Uttar Pradesh, India during 2014-2015. The average minimum and maximum temperature recorded between 6 $^0$C (December, 2014 and January, 2015) to $31^0$ C (March, 2015) and mean rainfall ranged between 0 to 76 mm during the cropping period (Figure 1. Metrological data during the cropping period October, 2014 to March, 2015). For soil analysis (Table 1), triplicate form of soil samples were collected (0-15 cm soil depth) before the treatment application from respective treatment blocks. pH and electrical conductivity (EC) of soil were determined by electrodes (Orion) using soil/double distilled water in a ratio of 1:2.5 (w/v) as filtered extract. Total organic matter and available potassium were measured according to the method of Jackson (1962). Available phosphorus was determined by the process given by Olsen et al., (1983) whereas; available nitrogen was determined by the approach suggested by Stanford and Smith (1978).

The experiment was tested under randomized block design (RBD) with three replication and 6 treatments viz:

**Table 1**

| S. No. | Symbol | Treatments |
|---|---|---|
| 1 | $T_1$ | Control |
| 2 | $T_2$ | Vermicompost (100%) |
| 3 | $T_3$ | *Azotobacter* (100%) |
| 4 | $T_4$ | Vermicompost (75 %) + *Azotobacter* (25%) |
| 5 | $T_5$ | Vermicompost (50%) + *Azotobacter* (50%) |
| 6 | $T_6$ | Vermicompost (25%) + *Azotobacter* (75%) |

A total 18 plots were made (2.1 x 1.2 $m^2$ size of each plot) with 0.5 m drainage channel made between the two replications. Each plot contains 6 rows (rows were raised by 15 cm from main field) and runners were planted at distance of 30 x 15 cm (6 plants in each row), accommodated 36 plants in each plot. The strawberry runners were planted during the last week of October, 2014. The planting materials were collected from M/s Beniwal strawberry Research Farm, New Delhi, India during the last week of October, 2014. The runners were kept for a day for proper acclimatization to the experimental site. Recommended dose of vermicompost and *Azotobacter* were applied at the rate of 100 q/ha, and 30 ml/L water, respectively. Vermicompost applied by broadcasting in the plots and mixes with the soil manually before planting of runners. Vermicompost were applied at the rate of 1.62 kg (100 %), 1.21 kg (75 %), 0.81 kg (50 %), 0.40 kg/plot (25 %) and *Azotobacter* was applied by dipping of strawberry runners in 30 ml per litre water (100 %), 22.5 ml per litre (75 %), 15 ml per litre (50 %) and 7.5 ml per litre water (25 %) for 20 minutes just before the planting.

Various intercultural operations viz. weeding, hoeing etc. were done frequently for better growth and development of plants and for yield as well. Straw mulching was applied around the plants which help in moisture conservation and also to restrict the weed population. For providing proper moisture to the plants frequent irrigation applied at weekly interval. Plant protection measures were also applied during the cropping period.

The fruits of Strawberry were harvested very carefully by hand picking at an interval of 3-4 days during cool morning hours. The fruits of strawberry were harvested at commercial maturity when >80% of the fruit surface turned red colour.

Observations were recorded on different physical characters of plants from inner plant population of each plot to avoid border effect. The data were measured with the help of digital vernier callipers on plant height (cm), spread of the plant (cm), fruit width (cm), fruit length (cm), leaf length (cm) and leaf width (cm). Leaf area ($cm^2$) was recorded by portable leaf area meter. Data were recorded manually by counting number of leaves per plant, number of runners per plant, number of flowers per plant and number of fruits per plant separately from each plant kept for the observation purpose. Amongst the yield parameters, fruit weight (g), fruit yield per plant (g) and fruit yield per plot (kg) were recorded with the help of digital electronic balance (Industrial Digital Scale Kern EW-420-3NM). Volume of fruit was estimated by water displacement method as suggested by Ranganna (1986). Statistical analysis of the recorded data was carried out by the method of analysis of variance as per the method of Gomez and Gomez (1984).

## RESULTS AND DISCUSSIONS

The result of present study "response of vermicompost and *Azotobacter* on growth and yield of sweet Charlie strawberry" is presented in table -2 and table-3. The plant height (11.25 cm) and plant spreading (27.76 cm) were found maximum in $T_4$ followed by $T_5$ (11.01 cm and 26.86 cm), respectively. The maximum numbers of leaves (14.28), leaf length (5.25 cm), leaf width (4.17 cm), leaf area (33.07 $cm^2$) were observed in $T_4$ followed by $T_5$. The maximum numbers of runners per plant (3.73) were recorded in $T_6$.

The maximum number of flowers and fruits per plant was recorded in $T_5$ (15.91 and 6.76) followed by $T_4$ (15.90 and 6.70), respectively. The maximum fruit length (5.33 cm), fruit width (3.96 cm), fruit weight (20.96 g), fruit volume (20.93 ml), fruit yield per plant (124.46 g) and fruit yield per plot (4.43 kg) were recorded in $T_4$ followed by $T_5$.

Maximum plant height, plant spreading, number of leaves, leaf length, leaf width, leaf area, fruit length, fruit width, fruit weight, fruit volume, fruit yield per plant, fruit yield per plot were observed in $T_4$ (Vermicompost 75 % + *Azotobacter* 25 %) followed by $T_5$ (Vermicompost 50 % + *Azotobacter* 50 %) which may due to the higher concentration of vermicompost (75 %) along with *Azotobacter* (25 %) as vermicompost has been found effective for improving soil aggregation, structure, fertility, increasing soil microbial diversity, populations, enzymes, improving moisture-holding capacity of soils, increasing cation-exchange capacity (CEC) and finally also crop yields (Tejada et al., 2008). Vermicomposts are comprised of large amounts of humic substances, some of the effects of which on plant growth are similar to those of soil-applied plant growth regulators (Azarmi et al., 2008; Kumar et al., 2015). The availability of plant growth-influencing substances in vermicomposts such as plant growth hormones and humic acids has also been suggested as a possible factor contributing to increase micro-biological processes, plant growth and yield (Pramanik et al., 2010). Vermicompost is also responsible for improving soil enzymatic properties significantly upon its amendment, in case of dehydrogenase β-glucosidase, urease, protease and cellulose activities (Saha et al., 2008; Romero et al., 2010). Various greenhouse and field studies have examined positive significant effects of vermicomposts on growth and yield of cereals legumes, vegetables, ornamental, flowering plants and other field crops (Arancon et al., 2008; Sangwan et al., 2010). *Azotobacter was* also applied in small concentration (25 %) ($T_4$) which is responsible for nitrogen fixation, delivering combined nitrogen to the plant and the production of phytohormone-like substances that alter plant growth and morphology, and bacterial nitrate reduction, which increases nitrogen accumulation in inoculated plants and finally improve the growth of plants (Mrkovacki and Milic, 2001).

Maximum number of runners was recorded in treatment $T_6$ followed by $T_3$ which may be due to the higher concentration of Azotobacter (75 %) along with vermicompost (25 %) as *Azotobacter* responsible for secretion of growth promoting substances especially cytokinin which increased the runner production (Nazir et al., 2006) and vericompost which is also responsible for better plant growth and development.

## CONCLUSIONS

The present study clearly revealed that $T_4$ [Vermicompost (75 %) + Azotobacter (25%)] was found more effective for vegetative growth and yield of strawberry as compared to other treatment combinations.

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## APPENDICES

**Table 1: Chemical and Physical Properties of the Soil at the Beginning of the Experiment**

| Soil Properties | Result |
|---|---|
| Sand (%) | 61 |
| Silt (%) | 15 |
| Clay (%) | 11 |
| pH | 6.8 |
| Organic matter (%) | 1.6 |
| Available nitrogen (%) | 0.06 |
| Available potassium (ppm) | >331 |
| Available phosphorus (ppm) | > 23 |

**Table 2: Response of Vermicompost and *Azotobacter* on Growth of 'Sweet Charlie' Strawberry**

| Treatments | Plant Height (Cm) | Plant Spreading (Cm) | Number of Leaves Per Plant | Leaf Length (Cm) | Leaf Width (Cm) | Leaf Area ($Cm^2$) | Number of Runners Per Plant |
|---|---|---|---|---|---|---|---|
| Control | 9.90 | 25.63 | 12.93 | 5.01 | 3.38 | 22.44 | 2.53 |
| VC (100 %) | 10.76 | 26.56 | 13.90 | 5.14 | 3.86 | 27.64 | 3.40 |
| AZO (100%) | 10.68 | 26.50 | 13.43 | 5.03 | 4.03 | 25.17 | 3. 50 |
| VC (75%) + AZO (25%) | 11.25 | 27.76 | 14.28 | 5.25 | 4.17 | 33.07 | 3.43 |
| VC (50%) + AZO (50%) | 11.01 | 26.86 | 14.26 | 5.22 | 4.15 | 32.79 | 3.46 |
| VC (25%) + AZO (75%) | 10.99 | 26.96 | 14.30 | 5.14 | 4.03 | 32.70 | 3. 73 |
| CD at 5% | 0.65 | 0.82 | 0.89 | 0.15 | 0.19 | 6.46 | 0.52 |

VC= Vermicompost; AZO= *Azotobacter*

**Table 3: Response of Vermicompost and *Azotobacter* on Yield of 'Sweet Charlie' Strawberry**

| Treatments | Number of Flowers Per Plant | Number of Fruits Per Plant | Fruit Length (Cm) | Fruit Width (Cm) | Fruit Weight (G) | Fruit Volume (Ml) | Fruit Yield Per Plant (G) | Fruit Yield Per Plot (Kg) |
|---|---|---|---|---|---|---|---|---|
| Control | 12.96 | 6.80 | 4.47 | 3.10 | 12.84 | 12.70 | 81.85 | 1.55 |
| VC (100 %) | 14.80 | 6.50 | 5.16 | 3.20 | 18.50 | 18.56 | 90.72 | 2.16 |
| AZO (100%) | 13.26 | 6.50 | 5.23 | 3.18 | 19.16 | 19.13 | 105.27 | 3.10 |
| VC (75%) + AZO (25%) | 15.90 | 6.70 | 5.33 | 3.96 | 20.96 | 20.93 | 124.46 | 4.43 |
| VC (50%) + AZO (50%) | 15.91 | 6.76 | 5.26 | 3.83 | 19.83 | 19.76 | 121.03 | 4.35 |
| VC (25%) + AZO (75%) | 15.80 | 6.73 | 5.21 | 3.39 | 19.56 | 19.30 | 120.82 | 4.22 |
| CD at 5% | 0.62 | 0.17 | 0.50 | 0.34 | 4.10 | 4.31 | 22.43 | 0.97 |

VC= Vermicompost; AZO= *Azotobacter*

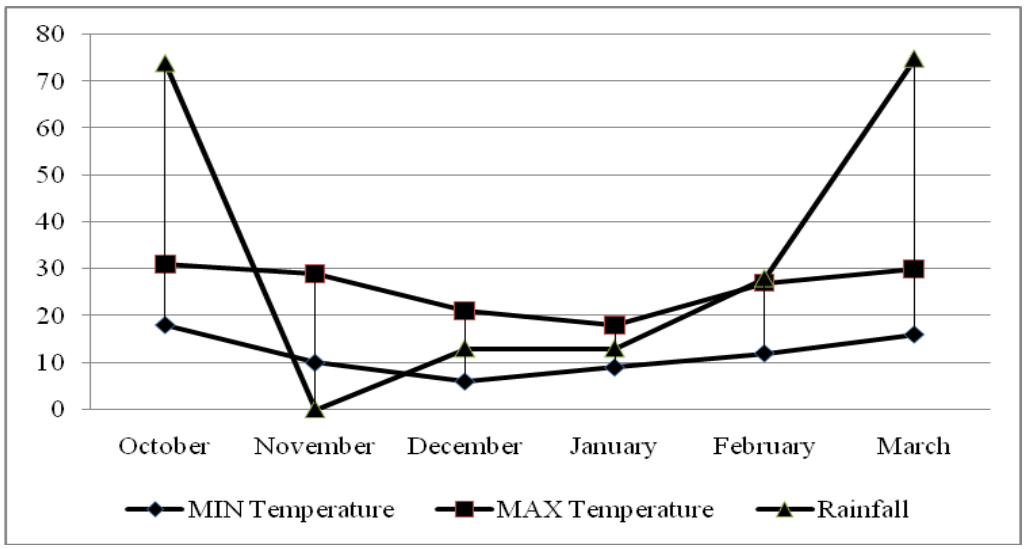


**Figure 1: Metrological Data during the Cropping Period (October, 2014 to March, 2015)**